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## ABSTRACT

Moving off the planet will be a defining moment of this century as landing on the Moon was in the last. For that to happen—for humans to go where humans cannot go—simulation is the sole solution. NASA supports simulation for life-cycle activities: design, analysis, test, checkout, operations, review and training. We contemplate time spans of a century and more, teams dispersed to different planets and the need for systems that endure or adapt as missions, teams and technology change. Without imagination such goals are impossible. But with imagination we can go outside our present perception of reality to think about and take action on what has been, is and, especially, what might be.

Consciously maturing an imagined, possibly workable, idea through framing it to optimization to design, and building the product provides us with a new approach to innovation and simulation fidelity. We address options, analyze, test and make improvements in how we think and work. Each step includes increasingly exact information about costs, schedule, who will be needed, where, when and how.

NASA is integrating such thinking into its Exploration Product Realization Hierarchy for simulation and analysis, test and verification, and stimulus response goals. Technically NASA follows a timeline of studies, analysis, definition, design, development and operations with concurrent documentation.

We have matched this Product Realization Hierarchy with a continuum from image to realization that incorporates commitment, current and needed research and communication to ensure superior and creative problem solving as well as advances in simulation. One result is a new approach to collaborative systems. Another is a distributed observer network prototyped using game engine technology bringing advanced 3-D simulation of a simulation to the desktop enabling people to develop shared consensus of its meaning.

Much of the value of simulation comes from developing in people their ability to make good decisions and reflexes supporting impressive achievement. Synthesizing imagination systematically into our work—and thus our success—is a challenge. NASA engineers have inventive minds, and the task is determining how best to enable them to devise the simulation and other innovations that will make a story so clear and so intellectually sound that people can carry out the mission for 50-100 years. This demands skills and knowledge traditionally under-respected and under-represented in technology organizations. But we are beginning to see that the process encourages efficiency and enables us to attain more effective results.

We have to elicit imaginative, intelligent and effective ways to make better use than ever of the minds we have and will have available. We have to accept the challenge to accomplish tasks among dispersed interdisciplinary teams who must overcome changing priorities and technology, time and distance in order to maximize interactivity and innovation as never before. Attention to the process of innovation is a practical means to increase the efficiency of our intelligence. We have an obligation to reexamine and improve the process by which we approach and exercise innovation—as we accept the charge to move off the planet.

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